Proceedings of the Workshop on Ventilation Engineering Controls for Environmental Tobacco Smoke in the Hospitality Industry

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PREFACE

In June 1998, the Occupational Safety and Health Administration (OSHA) sponsored a Technical Workshop on Ventilation Engineering Controls for Environmental Tobacco Smoke Exposure in the Hospitality Industry. This 3-day workshop, held in Fort Mitchell, Kentucky, was coordinated by ACGIH, the American Conference of Governmental Industrial Hygienists.

A panel of 14 experts was assembled to provide more information on ETS exposures and to discuss potential ventilation engineering controls for reducing these exposures in restaurants, bars, and gaming establishments. The panelists were either experienced ventilation engineers or facility management representatives from the hospitality industry.

Background

The Workshop on Ventilation Engineering Controls for ETS Exposure in the Hospitality Industry responded to a demonstrated need for more information on this subject. On April 5, 1994, OSHA published a Notice of Proposed Rulemaking on Indoor Air Quality (59 FR 15968) which included a comprehensive standard mandating the proper operation and maintenance of building systems, required control of point sources of pollutants, and required control of exposures from air pollutants generated by renovation and remodeling activities. The proposal also specified the conditions under which smoking could be allowed in the workplace. The employer had to establish designated smoking areas, permit smoking only in such areas, and ensure that these areas were enclosed and exhausted directly to the outside and maintained under negative pressure sufficient to contain tobacco smoke. Employees could not be required to enter the designated smoking areas as part of their normal work activities [59 F.R. at 16037].

The ETS provisions of the 1994 proposal received a substantial number of comments. While the ETS provisions were feasible for many employers, it became apparent to OSHA that in businesses where there is substantial contact between customers who smoke and workers (e.g., food, beverage and gaming industries), this provision was not easily applied as written. During the public hearing on the proposal, OSHA asked representatives of the hospitality industry for

information on engineering and administrative controls that could be used to protect workers; however, little information was submitted to the Agency in response.

The purpose of the 1998 Workshop was to obtain the much needed information on feasible engineering and work practice controls for the hospitality industry. It provided the setting in which ventilation engineers and facility management personnel could discuss the issues and postulate designs that could potentially reduce exposure to ETS.

Program Format

On the first day, each panelist delivered a 15- minute presentation. These presentations covered various topics, including local source capture versus general dilution ventilation; make-up air (e.g., supply air islands); ventilation performance monitoring; displacement ventilation systems; particulate and gas phase removal; and current practice for design, operations, and maintenance of Heating, Ventilation, and Air-Conditioning (HVAC) systems in gaming, restaurant, and beverage (bars) facilities.

On the second day, the panel explored the technological and economic feasibility of applying current prudent practice for the application of ventilation engineering controls to the hospitality sector. Various options were considered during wide-ranging discussions. The third day of the Workshop was devoted to exploration of the most promising possibilities and development of concensus evaluations and recommendations.

EXECUTIVE SUMMARY

Executive Summary

This section of the proceedings represents a synopsis of the important issues in considering engineering solutions to ETS exposures. The Chair has taken the liberty of expanding and refining the solutions discussed in the Workshop, including preparing sketches of the solutions to clarify issues discussed by the Panelists and to provide visual representation for readers of this document. In addition, some information in the text, especially references to published literature, was added by the Chair to clarify other issues.

Summary

Panelists discussed several possible engineering solutions for a variety of ETS exposure conditions in restaurants, bars, and the gaming industry. Displacement ventilation was deemed to have the greatest chance of producing substantial reductions. It could be less costly over time than the dilution methods currently used. It is unfamiliar to most HVAC engineers and presents some challenges in placing ducts, especially when retrofitting existing facilities. Ventilated ashtrays were thought to have less potential to dramatically reduce exposures, but they would reduce the quantity of ETS released into occupied spaces, yet would require very low levels of exhaust airflow. They would require some cooperation by smokers and would take up counter or table space.

Both methods could be used together, if necessary or desired. Both could be used in restaurants and bars. Displacement ventilation is relatively new and practical applications are too recent and sparse to state with confidence that it would apply to larger casinos or cases where turbulent mixing is not well-controlled. Likewise, it may be difficult to use ventilated ashtrays on gaming tables because they would obscure some hand movements, and issue important in gambling establishments.

Introduction

The mission of this group was to develop engineering solutions to ETS exposures in restaurants, bars, and gaming institutions. This task is complicated by the lack of a recognized standard for acceptable exposure levels and by the lack of some important information. Although there have been extremely useful surveys of exposures at specific sites (Siegel, 1993; Trout, et al., 1998; Kado, et al., 1991; Phillips, et al., 1998; Hammond, et al., 1995; Pirkle, et al., 1996), it was not clear to Panelists what the typical levels of exposures to employees in restaurants, bars, and gaming establishments would be if current ventilation strategies were as well-executed as they believed them to be in their own establishments. Furthermore, for most ventilation interventions it is difficult to predict the reduction in exposures that one can expect, in part because efficacy depends on many factors the designer cannot control – and in this case can only speculate about. Nevertheless, based on the information available and experience with other airborne contaminants, we can propose measures that we believe will substantially reduce ETS emissions, and thus, exposures to workers. The actual magnitude of those reductions can be determined experimentally. Whether they are sufficient can be determined when ACGIH or others set a standard of acceptable exposure.

Like any other setting where engineering controls are considered, the design of ventilation controls for ETS reduction must consider sources of exposure, mechanisms of exposure, constraints imposed by material handling (e.g., serving food or drinks); "work practices" (e.g., standing within arm's reach and avoiding a hurried or unfriendly appearance); competing air motions (e.g., jets from diffusers, convection); and source strength, location and mobility.

Identification of Major Issues

To develop engineering solutions to ETS exposures in restaurants, bars, and gaming institutions, it is helpful to identify important issues. It is useful to divide these issues into the following categories:

1) Vital information that is missing or incomplete;

2) Source locations;

3) Reduction in ETS that must be attained;

4) Smoker behaviors necessary for each solution to succeed;

5) Assumptions about smoker behavior and likelihood of adopting specific requested behaviors that may be necessary for different solutions to succeed in substantially reducing ETS;

6) Likely reduction in ETS exposures attainable with each method; and

7) Cost factors and limitations.

Vital Information that is Missing or Incomplete

There are several issues related to ETS about which much more needs to be known to fully evaluate possible solutions. Among them are:

1) The velocity of cigarette and cigar smoke at different distances above the source. This information is crucial if a downdraft approach is to be attempted. The initial rise velocity is particularly important. Based on observation and the view of the Panelists, the velocities are far too great for downdraft strategies to work.

2) Whether and to what degree increasing the airflow near a source will increase the burn rate, perhaps discouraging smokers from cooperating in holding their cigarettes or cigars near or within small hoods. This is important because roughly half of cigarettes already are burned off between puffs.

3) The third important issue is buildup of contaminants inside small enclosures or hoods used to control ETS at its source, and in ducts or pipes used to transport the contaminated air to the outside. No panelist was aware of any published cigarette transport velocity, and it is not at all certain that high velocities would prevent condensation or adhesion of sticky tars on such surfaces. Effective filters may require excessive pressures, and they may be poorly maintained.

4) Optimum filters and their placement (in the hood or near the fan).

5) Whether filtered air can be returned to occupied spaces or should be exhausted to the outdoors. Wampler, et al (1995) found that filters in commonly used "smokeless" ashtrays failed to adequately remove particulate or gaseous contaminants even with fresh filters. Panelists from the restaurant industry pointed out the difficulty of providing maintenance for such equipment and the detrimental effects of the increased fan pressures required if filters were added to central systems.

It is possible that some of the information listed above is in the published literature but that no panelist was aware of it. All of the missing information could be supplied by specific research or by documented experience.

Smoking Locations

The main focus of this investigation is ETS exposure in restaurants, bars, and the gaming industry (e.g., casinos). There are similarities and overlaps among the three. Indeed, gaming establishments generally have bars and often have restaurants on the premises, and restaurants often have bars. "Bars" often have food-serving tables as part of their service area. Finally, in some parts of the country many restaurants and bars have gambling machines -- sometimes located very near tables in food-serving areas. However, it is assumed here that solutions that work for gaming machines, bars and restaurant tables will work all types of establishments in the hospitality industry.

Thus, engineering controls are discussed in terms of location of activity rather than the type of establishment. Areas of concern are:

- Tables and booths where food is served
- Bars, whether in restaurants, casinos, or anywhere else
- Gaming (which in smaller operations may be co-mingled with food-serving areas and the bar:
  - gaming tables
  - slot machines
  - video games
- Designated smoking rooms/lounges (workers must serve there, also)
- Stationary employees in smoke areas:
  - service area (if shares ambient air from smoking zone)
  - change booth (typical in gaming)
  - cashier (for restaurants and bars).

Sources of Smoke

Although cigarettes, cigars, and pipes produce environmental tobacco smoke, the main concern of this workshop was cigarettes. It is possible, and perhaps likely, that controls that are successful for cigarettes will be equally successful for cigars (except odor control). According to the Panelists, pipe smoking in gaming establishments and restaurants appears to be extremely rare these days, so it will not be considered here.

The effluent from burning cigarettes is either released directly to the air (sidestream smoke) or first inhaled by the smoker through the cigarette then exhaled (mainstream or "second-hand" smoke). Roughly half of the effluent comes from mainstream smoke and nearly all of the rest from sidestream smoke (Evans and Sefton, 1992; Dimich and Kobayashi, 1982). Most of the initial mass is gaseous, but given the aerodynamics of small particles in air, it is largely irrelevant to ventilation control whether the effluent is a gas or particulate (except when filtration is considered). The relative proportions of different ETS constituents in sidestream and mainstream smoke are somewhat different, but perhaps not enough that the differences should substantially affect control strategies. The important difference between sidestream and mainstream smoke is that exhaled mainstream smoke is diffused over a relatively large area as the smoker exhales it -- unless the smoker voluntarily blows it into a nearby receptacle. The sidestream smoke is always a point source, and thus potentially can be control by local ventilation at that point. As was discussed in Robert Hughes's presentation, cigarettes may not be held in one location. A moving point source is effectively a diffuse source.

Thus, point-source control strategies that are efficacious with sidestream smoke may be sharply less effective with exhaled mainstream smoke. Hence, the relative contribution of sidestream and mainstream

smoke is an important consideration in selecting control strategies. Important issues for mainstream smoke are the velocity and direction of smokers' exhalations and whether smokers are willing to modify the direction of exhalation. If they blow smoke towards workers, it is likely that no ventilation solution could be effective.

There are important issues concerning sidestream smoke. It may be released at a point (the tip of the cigarette), but that point may not be stationary. When not inhaling, the smoker can hold the burning cigarette by hand or leave it burning in an ashtray or other place of rest. Designing, installing, and operating ventilation controls for mobile objects is much more difficult than doing the same for stationary objects. Hence, it is important to know the fraction of time a smoker typically holds the cigarette and the fraction of time it burns at a stationary site. The latter may be increased by voluntary cooperation, but some minimal time (perhaps 10 percent of the total) is required to move the cigarette from the ashtray to the lips, take a puff, and then return the cigarette to the ashtray.

Smoker Behaviors Important to Source Control

According to Panelists, smoking behaviors are highly variable. Sometimes smoking is slow and leisurely and sometimes it is hurried and intense, depending on the smoker's mood, need for nicotine, and the time available to smoke. In the panelists' experience, smokers at restaurant tables generally smoke before a meal is served and afterwards, but not during a meal. Their smoking is generally unhurried. By contrast, at gaming tables, the excitement of gambling may promote more intense smoking behaviors at least part of the time.

The hurriedness or intensity of smoking is important because it may affect three variables important to source control:

1) ETS generation rate (due to number of puffs per minute and number of cigarettes burned per minute). According to the literature, a typical rate is one puff per minute at two seconds per puff, and eight puffs per cigarette.
2) Relative amount of time a cigarette burns freely (producing sidestream smoke) compared to the amount of time of inhalation (producing mainstream smoke). If the puff rate listed above is correct, the cigarette burns freely the vast part of the cycle. However, the burn rate during inhalation is vastly greater so that roughly half is burned during puffs.
3) Relative amount of time a burning cigarette is held in the hands compared to the amount of time it is left in an ashtray. By common observation, this is highly variable and may or may not be amenable to voluntary changes in behavior.

The voluntary modification of behavior may be crucial to some proposed controls – unless the smoker already exhibits such behaviors. A partial list of important behaviors include compliance in:

1) Smoking in designated areas,
2) Leaving cigarettes in ventilated ashtrays as much as possible, and/or
3) Blowing smoke toward ventilated points.

In the panelists' collective experience, cigarette smokers in their restaurants and gaming establishments nearly always comply with posted smoking rules, which generally are rigorously enforced on those who forget or do not comply voluntarily. It is possible that smokers would blow smoke towards ventilated points if requested. Panelists reported a common observation of smokers avoiding blowing smoke toward other individuals. It is increasingly common for such smokers to blow their smoke as vertically as possible.

Whether smokers would comply with requests to leave cigarettes in ventilated ashtrays when not puffing was unknown, but given the social stigma now strongly associated with releasing smoke into occupied spaces it is likely that most smokers would attempt to comply.

Monitoring of ETS

The best indicators of ETS exposure are thought to be the results of personal monitoring of airborne nicotine and the ultraviolet or fluorescent particulates. The literature strongly suggests that respirable suspended particulates (RSPs) are poorly correlated to more specific measures, in part because of often high background levels due to other sources. Body burdens of nicotine or cotinine in body fluids or hair can be used as surrogate measures of dose, although they are affected by individual processes in the body after exposure (Jaakkola et al, 1997).

Results of personal samples are affected by many factors that can vary widely over even short sampling times, such as proximity to the source and the direction and speed of movement of contaminated air. Hence, stationary area measurements of tobacco smoke constituents in different microenvironments near sources can be invaluable in evaluating the efficacy of control measures, particularly methods that seek to keep the contaminant from entering the ambient air of the room.

Important Constraints on Solutions

Important considerations for engineering solutions raised by the Panelists were related to acceptability by smoking patrons and costs to the establishment. For the former, controls should require little effort by the smoker and should not make them feel conspicuous or punished. For the latter, the need to stay within the airflow capacities of current package tempering units was paramount for all except Panelists representing very large gaming establishments.

One strategy to reduce operating costs is to clean ETS contaminated air and recirculate to occupied areas rather than exhausting it to the outdoors. However, such recirculated air must be effectively cleaned with filtration systems. The panel did not discuss filtration technologies and made no recommendations for particular systems, nor did it consider whether existing technologies were adequate. For that reason, all of the proposed controls simply assume that air released into occupied spaces will either be effectively cleaned before recirculation or will be brought from the outdoors after filtering for dust and tempering.

The cost of additional exhaust ventilation was $1-2cfm/year, a range of values considered reasonable by Panelists to be reasonable for building ventilated with package ventilation units.

General Categories of Proposed Solutions

Employee exposures to ETS can be reduced by eliminating the sources of ETS, reducing the rate of ETS emissions from sources, isolating the sources from the workers, and by controlling emissions with mechanical ventilation. Those three basic approaches can be sub-divided as follows:

1) Solutions that would eliminate sources (e.g., ban smoking) or reduce effluent rate (limit periods of smoking);
2) Solutions that isolate smokers from employees by, such as:
   requiring smokers to leave service areas to smoke (e.g., providing a "smoke room"), or
   serving smokers through a self-service window (no waiters/waitresses).
3) Well-mixed dilution ventilation;
4) Displacement ventilation; or
5) Local source capture and control using capture or enclosing hoods.

Many establishments already ban cigarette smoking on their premises due to local or state ordinances or on their own initiative. The option of banning smoking may be adopted by more and more establishments, especially if effective, relatively inexpensive controls cannot be developed. Restricting smoking to non-employee areas could be effective, but that strategy would not allow high levels of service to smoking patrons. Panelists from the restaurant and gaming industries described that as unacceptable. Indeed, if patrons were served through self-service windows the level of service would be comparable to "fast-food" restaurants.

The mission of this workshop was to explore solutions that would allow smoking within serviced areas while substantially reducing exposures to employees. Well-mixed dilution ventilation is currently widely applied. Its strategies and limitations are well known. Disputes over its adequacy are difficult to resolve given the absence of a prescribed quantitative level of acceptable control and measured data demonstrating degree of success or failure in keeping exposures below that level. In the opinion of some panelists, these methods provide inadequate control at best. Others believe they work adequately well now in most restaurants and in larger gaming institutions. However, public perceptions of what is considered adequate may continue to ratchet to increasingly lower levels of ETS odor and visible smoke. If that trend continues, it is possible and even likely that current strategies will be widely considered to be inadequate in the near future.

On the assumption that well-mixed dilution ventilation strategies may not be a satisfactorily efficient and effective method of controlling ETS exposures to workers in restaurants, bars, and gaming establishments, the Panel focused on the two remaining alternatives: displacement ventilation and local exhaust ventilation of ETS sources.

Proposed General Control for Mainstream and Sidestream Smoke: Displacement Ventilation

Displacement ventilation is a dilution design strategy that eschews the turbulence mixing necessary to traditional "well-mixed" designs. Displacement ventilation strategies assume that air released into a room is five to 10 degrees Fahrenheit cooler than the air already in the room. If released near floor level, this cool supply air will remain at floor level and travel across open spaces. Since people, mechanical devices, and electrical devices are generally much warmer than this supply air, the convection currents that arise above them carry warm contaminated air to the ceiling area where it can be removed by return air grilles. For this strategy, the rising plume from sidestream smoke is helpful. Likewise, since exhaled mainstream smoke is released at temperatures well above 90 degrees Fahrenheit, it should rise by convection even when mixing with nearby air is considered.

If the ceiling is relatively high (e.g. greater than eight feet) compared to the height of people, then the contaminants near the ceiling are well above the breathing zone. This strategy contrasts with most HVAC strategies, which attempt to mix the floor and ceiling air using the jets from the ceiling diffusers to provide the necessary the necessary kinetic energy.

To be successful, displacement ventilation requires that there be relatively little disturbance to the air by moving objects, jets of air, and so on. It works best when the supply air can be delivered very close to the floor, which requires that ducts and supply air grilles be installed at or near to the floor. Since a smoker's exhalation is forceful enough to disperse exhaled ETS at levels well below the head, smoker tendency or willingness to exhale upward could be important to this strategy.

Restaurant Panelists objected to the constraints on layout and aesthetics inherent to locating large diffusers near the floor. It may be possible to locate diffusers in the ceiling near walls and direct the air to the floor, but experimental verification is required to prove the feasibility of that compromise.